SWRHL-53r

SPECIAL BOVINE SAMPLING STUDY--PROJECT ROLLERCOASTER SITES

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ABSTRACT

Six bovine, three young animals and three aged animals, that had been grazing on or near the 1963 Project Rollercoaster sites were sacrificed in April 1967 to assess the body burden of ^{239}Pu in these animals.

Levels found in various tissues were higher than those found in bovine grazing on the NTS but far below the MPC levels established for humans. The maximum dose an individual could receive from consuming tissue from these animals is negligible. No pathology was found on either gross or microscopic examination that could be directly related to radiation.

Due to the obscure etiology of the described lesions, it would be impossible to reach any definite conclusions as to their origin; but it would appear to be due to some other cause than radiation, since the body burden of ^{239}Pu was well below those levels known to induce detectable radiation damage.

No statistical difference was found in the levels of ^{239}Pu between the young and aged animals.

Hilaria jamesii constituted 86% of the animals' diet.

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INTRODUCTION

During Project Rollercoaster which was held in the spring of 1963 on the Tonopah Test Range, ^{239}Pu was liberated in each of four separate events. As a result of these events, the Atomic Energy Commission, Nevada Operations Office (AEC/NVOO) in 1967 requested the U.S. Public Health Service, Animal Investigation Program to conduct a followup study of the cattle grazing on the contaminated sites to assess the uptake of this particular radionuclide.(4)

According to Glora and Aoki(2) considerable degradation of detectable surface activity has been noted on the sites; however, they further stated, "^{239}Pu is still present in sufficient quantity to present a potential health hazard unless access is adequately controlled." Although the project sites have been reasonably well closed to humans since the time of the events, range cattle have grazed periodically on and near the sites following the test series. The most highly contaminated portion of each Rollercoaster site is fenced to control access.

METHODS

Six head of range cattle (three mature animals and three young animals) which had been grazing on the Project Rollercoaster sites were purchased from the Daniel's Ranch Estate, transported to the Well 3 facility at the Nevada Test Site (NTS), and sacrificed on 26 April 1967.

Methods utilized for this sacrifice and investigation were essentially the same as those outlined in SWRHL ITR-11[5] and those in AIP-3[3] except for the submission of additional biological samples for ^{239}Pu analysis, additional tissue samples for histopathology, and rumen content samples for food habit analysis.

A portion of the biological sample was first submitted for gamma spectroscopy and then recombined with the remaining portion for ^{239}Pu analysis.

The following biological samples were collected:

1. For gamma spectroscopy:

   Abomasum Contents
   Abomasum Tissue
   Liver
   Lung, Tips of Each Lobe
   Muscle
   Rumen Contents
   Thyroid

2. For radiochemistry:

   Bone, Femur (Left & Right)
   Kidneys
   Liver
   Lungs
   Muscle
   Pulmonary Lymph Nodes
   Rumen Contents
   Spleen

3. For histopathology:

   Bone (Costochondral Junction 8th Rib)
   Heart
   Kidney
   Liver
   Lung
   Muscle
   Pulmonary Lymph Nodes
   Spleen
   Thyroid
   Abnormal Tissue

Tissue samples were taken from three young and three old bovine. Plutonium-239 analysis was then done on these samples. The pCi/g ash

concentrations found in the tissues are given in Table 1. Means and standard deviations were calculated for each tissue for the three young, the three aged, and the combined group. Nondetectable activities were treated as zero in these calculations. A t-statistic was calculated for the difference between the means of the young and aged bovine for each tissue.

RESULTS

The average concentrations of plutonium-239* in bone was 3.86 ± 3.35 pCi/g ash (Table 1). Values in other biological samples ranged from a low of 0.09 ± 0.03 pCi/g ash in liver to a high of 0.80 ± 0.41 in spleen.

Average strontium-89 and -90 values in bone of 6.7 ± 1.7 and 11.7 ± 0.6 pCi/g ash, respectively, are comparable to those values found in bovine from other areas on the state and the NTS.[6]

Iodine-131 at an average level of 6.28 pCi/g tissue was detected in each thyroid sampled.

Other programmed nuclides were nondetectable in most samples collected. Those few exceptions were at or near nondetectable levels with our counting systems.

The calculated t-statistics can be compared with the t-distribution values for four degrees of freedom: t(95%) = 2.776 and t(99%) = 4.604. No significant difference was found between the young and aged bovine tissues. The means, standard deviations, and t-statistics are presented in Table 2.

Gross and microscopic pathology in this group of six cows (Appendix B) fell within three categorical groups. Group 1 would be those lesions directly attributable to the method of sacrifice and the terminal struggling prior to death. Included in this group would be all gross

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*Plutonium-239 accounts for 95% of the Pu counted.

Table 1. Concentrations of pCi ^{239}Pu/g Ash Found in Selected Biological Samples Collected from Young and Aged Bovine Grazing on the Project Rollercoaster Sites.

TISSUE	AGED BOVINE			YOUNG BOVINE		
	BOV-1-N14-67	BOV-2-N14-67	BOV-3-N14-67	BOV-4-N14-67	BOV-5-N14-67	BOV-6-N14-67
Bone (Femur)	9.20 ± 0.52*	0.92 ± 0.23	0.60 ± 0.06	1.81 ± 0.33	5.25 ± 0.39	5.38 ± 0.44
Liver	0.07 ± 0.04	0.07 ± 0.05	0.11 ± 0.04	0.07 ± 0.06	0.12 ± 0.07	0.12 ± 0.06
Lung	0.31 ± 0.02	0.38 ± 0.12	0.35 ± 0.07	2.40 ± 0.10	0.10 ± 0.06	0.20 ± 0.07
Muscle	0.67 ± 0.14	0.26 ± 0.11	N.D.	0.52 ± 0.13	0.56 ± 0.13	0.63 ± 0.14
Rumen Contents	0.81 ± 0.06	0.77 ± 0.07	0.27 ± 0.07	1.29 ± 0.91	0.72 ± 0.07	0.37 ± 0.08
Spleen	0.87 ± 0.14	0.90 ± 0.08	0.52 ± 0.10	0.67 ± 0.17	1.50 ± 0.20	0.32 ± 0.17
Pulmonary Lymph Nodes	N.D.**	1.00 ± 0.90	N.D.	N.D.	N.D.	0.09 ± 0.05
Kidney	0.34 ± 0.03	1.46 ± 0.10	0.38 ± 0.06	0.06 ± 0.06	0.97 ± 0.16	0.51 ± 0.10

*Counting Error - 2 σ

**Not Detectable

Table 2. Statistical Summary of ^{239}Pu Concentrations in pCi/g Ash Found in Selected Biological Samples Collected from Young and Aged Bovine Grazing on the Project Rollercoaster Sites.

Tissue	Three Aged Bovine	Three Young Bovine	All Six Bovine	t-Statistic
Bone (Femur)	3.57 ± 4.88*	4.15 ± 2.02	3.86 ± 3.35	0.16
Liver	0.08 ± 0.02	0.10 ± 0.03	0.09 ± 0.03	0.78
Lung	0.35 ± 0.04	0.90 ± 1.30	0.62 ± 0.88	0.60
Muscle	0.31 ± 0.34	0.57 ± 0.06	0.44 ± 0.26	1.07
Rumen Contents	0.62 ± 0.30	0.79 ± 0.46	0.70 ± 0.36	0.44
Spleen	0.76 ± 0.21	0.83 ± 0.61	0.80 ± 0.41	0.15
Pulmonary Lymph Nodes	0.33 ± 0.58	0.03 ± 0.05	0.18 ± 0.40	0.73
Kidney	0.73 ± 0.64	0.51 ± 0.46	0.62 ± 0.51	0.39

*Mean ± Standard Deviation about the Mean.

and microscopic lesions described in the lung, focal hemorrhage in the cortex and medulla of a lymph node, fracture of a mandible, rupture of the rumen wall with spillage of rumen contents into the peritoneal cavity, myositis, and focal accumulations of polymorphonuclear leucocytes in the sinusoids of the liver, and of mononuclear leucocytes in the cardiac muscle.

Group 2 would be those lesions that are generally considered to be of an acquired nature. Included in this group would be the following microscopic lesions: sarcosporidia in the cardiac and skeletal muscles and focal acute interstitial nephritis and focal pyelonephritis in the kidney.

Group 3 would be those lesions that could possibly be attributable to prolonged exposure to small quantities of alpha, beta, or gamma radiation. Included in this group would be the following microscopic lesions: an increase in the connective tissue in the medulla and a degree of lymphoid exhaustion in the cortex of a lymph node, focal accumulations of immature and mature lymphocytes in the kidney suggestive of an early lymphosarcoma, and moderate myeloid metaplasia in a spleen.

Hilaria jamesii constituted 86% of the six animals' diet on this range (Appendix C).

DISCUSSION

The isotope ^{239}Pu with a physical half-life of 2.44×10^4 years and a biological half-life of about 200 years is of major concern when it is available to biological organisms.

Essentially, the total quantity of plutonium which is incorporated into an organism remains there and provides a constant lifetime dose. Since plutonium is primarily an alpha emitter, the hazard is from internal deposition and subsequent incorporation into the cells of the organism. Only about 0.003%[1] of ingested plutonium is absorbed into the blood and available to the body for metabolism. Inhalation is the most important consideration. On the Rollercoaster sites, ^{239}Pu is available to bovine by both routes. However, the results obtained from this study indicate that the major route is ingestion, since the pulmonary lymph nodes contained essentially nondetectable amounts of this isotope.

The critical organ for this isotope is bone. The maximum permissible body burden for man as shown in the National Bureau of Standards Handbook 69[7] is 0.04 μCi. Considering that 90% of this isotope is deposited in bone and using the standard man's 7,000 g bone mass with a conversion factor of about 30% ash weight, we can convert the maximum permissible body burden as

$$\frac{(40{,}000 \text{ pCi})\ (0.9 \text{ bone deposition})}{(7{,}000 \text{ g})\ (0.3 \text{ conversion wet bone to ash})} = 17.1 \text{ pCi/g bone ash MPBB}$$

This is a factor of almost twice the maximum bone burden of any of the animals and slightly more than four times the average burden. It is realized that only general comparisons can be made between man and bovine. No MPBB has been calculated for bovine; and, since bovine have much shorter life spans than man, these MPBB's obviously would not be the same.

Since the cattle that graze on this area are sold on the open market and available for general public consumption, the maximized dose a person

would receive eating 8 oz of meat at each meal for 50 years has been calculated, assuming that the amount of ^{239}Pu would remain the same in the muscles of these animals for 50 years.

$$24 \frac{\text{oz meat}}{\text{day}} \times 28.4 \frac{\text{g}}{\text{oz}} = 682 \text{ g/day} \times 0.44 \frac{\text{pCi } ^{239}Pu}{\text{g}} = 300 \text{ pCi/day}$$

Critical organ = bone. ICRP II data:

$$f_w = 2.4 \times 10^{-5}$$

$$T_{eff} = 7.2 \times 10^4 \text{day} \rightarrow \lambda_{eff} = \frac{0.693}{7.2 \times 10^4} = 9.6 \times 10^{-6} \text{ day}^{-1}$$

$$m = 7 \times 10^3 \text{ g bone}$$

$$\Sigma EF(RBE)_{\eta} = 270$$

Assume 50 year irradiation and intake → then percent equilibrium reached is $1-e^{-\lambda t} = 0.16$ from ICRP II

$$P = \text{daily intake to bone} = \frac{\mu Ci}{day} \times f_w = 300 \times 10^{-6} \times 2.4 \times 10^{-5} = 7.2 \times 10^{-9}$$

Integrated dose:

$$D_o^t = 51.1 \left(\frac{P}{m\lambda}\right) (\Sigma EF)\left[t - \frac{1}{\lambda}(1-e^{-\lambda t})\right]$$

$$= 51.1 \left[\frac{7.2 \times 10^{-9}}{(7 \times 10^3)(9.6 \times 10^{-6})}\right] (270) \left[(50 \times 365) - \left(\frac{1}{9.6 \times 10^{-6}}\right)(0.16)\right]$$

$$= 2.4 \text{ rem}$$

At the end of 50 years a person would have received 2.4 rem. This may be compared to a recommended dose of 0.5 rem/year for members of the general public (ICRP 9) or 0.5 X 50 = 25 rem in 50 years.

It appears from these calculations that the potential hazard to the public from consuming this meat is negligible.

Group 1 lesions attributable to the method of sacrifice are presented primarily for clarification of the overall picture. These lesions will vary with each individual animal and each sacrifice and have no clinical significance in our studies.

Group 2 lesions were consistent with previously reported lesions in cattle sacrificed at Knoll Creek, Delamar Valley, and the Nevada Test Site semiannually. These lesions are assumed to be due to natural processes occurring in random populations.

Group 3 lesions are of a type that could be attributable to prolonged exposure to low levels of ingested radioisotopes. The lesions have also been described in animals throughout the United States that have had no known exposure to radiation above background levels.

The species of grass *Hilaria jamesii* when present on grazing areas is commonly a major portion of the bovine diet. This food habit analyses indicated no deviations from the expected diet.

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APPENDIX

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APPENDIX A

RADIOANALYSIS RESULTS

Table A-1. Gamma Spectroscopy - Rumen Contents.

AIP NO.	^{131}I pCi/g	^{144}Ce pCi/g	^{140}Ba pCi/g	^{106}Ru pCi/g	^{137}Cs pCi/g	K g/g
BOV-1-RuC-67	ND	ND	ND	ND	ND	.0020
BOV-2-RuC-67	ND	ND	ND	ND	ND	ND
BOV-3-RuC-67	ND	ND	ND	ND	ND	.0012
BOV-4-RuC-67	ND	ND	ND	.313	ND	ND
BOV-5-RuC-67	ND	ND	ND	ND	ND	ND
BOV-6-RuC-67	ND	.836	ND	ND	ND	.0019
AVERAGE						.0017

ND = Nondetectable

Table A-2. Gamma Spectroscopy - Thyroid.

AIP NO.	^{131}I pCi/g	^{144}Ce pCi/g	^{140}Ba pCi/g	^{106}Ru pCi/g	^{137}Cs pCi/g	K g/g
BOV-1-Th-67	4.43	ND	ND	ND	ND	.0080
BOV-2-Th-67	5.13	ND	ND	ND	ND	ND
BOV-3-Th-67	7.74	ND	ND	ND	ND	ND
BOV-4-Th-67	5.76	ND	ND	ND	ND	ND
BOV-5-Th-67	6.98	ND	ND	ND	ND	ND
BOV-6-Th-67	7.76	ND	ND	ND	ND	ND
AVERAGE	6.28					

ND = Nondetectable

Table A-3. Gamma Spectroscopy - Abomasum Contents.

AIP NO.	^{131}I pCi/g	^{144}Ce pCi/g	^{140}Ba pCi/g	^{106}Ru pCi/g	^{137}Cs pCi/g	K g/g
BOV-1-AbC-67	.109	ND	ND	ND	.440	.0032
BOV-2-AbC-67	ND	ND	ND	ND	ND	.0060
BOV-3-AbC-67	ND	ND	ND	ND	ND	.0046
BOV-4-AbC-67	.014	.052	.051	ND	ND	.0043
BOV-5-AbC-67	ND	ND	ND	ND	.209	.0027
BOV-6-AbC-67	.313	ND	.173	ND	.191	.0059
AVERAGE	.145				.280	.0044

ND = Nondetectable

Table A-4. Gamma Spectroscopy - Abomasum Tissue.

AIP NO.	^{131}I pCi/g	^{144}Ce pCi/g	^{140}Ba pCi/g	^{106}Ru pCi/g	^{137}Cs pCi/g	K g/g
BOV-1-AbT-67	ND	ND	ND	ND	ND	.0019
BOV-2-AbT-67	ND	ND	ND	.353	ND	.0016
BOV-3-AbT-67	ND	ND	ND	ND	.067	.0017
BOV-4-AbT-67	ND	ND	ND	ND	ND	.0025
BOV-5-AbT-67	ND	ND	ND	ND	ND	.0027
BOV-6-AbT-67	ND	ND	ND	ND	ND	.0040
AVERAGE						.0024

ND = Nondetectable

Table A-5. Gamma Spectroscopy - Lung.

AIP NO.	^{131}I pCi/g	^{144}Ce pCi/g	^{140}Ba pCi/g	^{106}Ru pCi/g	^{137}Cs pCi/g	K g/g
BOV-1-Lu-67	ND	ND	ND	ND	.070	.0020
BOV-2-Lu-67	ND	ND	ND	ND	ND	ND
BOV-3-Lu-67	ND	ND	ND	ND	ND	ND
BOV-4-Lu-67	.137	ND	ND	ND	ND	ND
BOV-5-Lu-67	ND	ND	ND	ND	ND	ND
BOV-6-Lu-67	ND	ND	ND	ND	ND	.0021

ND = Nondetectable

Table A-6. Gamma Spectroscopy - Muscle.

AIP NO.	^{131}I pCi/g	^{144}Ce pCi/g	^{140}Ba pCi/g	^{106}Ru pCi/g	^{137}Cs pCi/g	K g/g
BOV-1-Mu-67	ND	ND	.036	ND	.090	.0029
BOV-2-Mu-67	ND	ND	ND	ND	ND	.0043
BOV-3-Mu-67	ND	ND	ND	ND	ND	.0042
BOV-4-Mu-67	ND	ND	ND	ND	.041	.0035
BOV-5-Mu-67	ND	ND	ND	.129	.113	.0046
BOV-6-Mu-67	ND	ND	ND	ND	.145	.0046
AVERAGE					.097	.0040

ND = Nondetectable

Table A-7. Gamma Spectroscopy - Liver.

AIP NO.	^{131}I pCi/g	^{144}Ce pCi/g	^{140}Ba pCi/g	^{106}Ru pCi/g	^{137}Cs pCi/g	K g/g
BOV-1-Li-67	ND	ND	ND	ND	ND	.0029
BOV-2-Li-67	ND	ND	ND	ND	ND	.0039
BOV-3-Li-67	ND	ND	ND	ND	ND	.0020
BOV-4-Li-67	ND	.415	ND	ND	ND	.0020
BOV-5-Li-67	ND	ND	ND	ND	ND	.0024
BOV-6-Li-67	ND	.605	ND	ND	ND	.0033
AVERAGE						.0027

ND = Nondetectable

Table A-8. Bone Femur - ^{89}Sr and ^{90}Sr Results - Duplicate Samples.

	pCi ^{89}Sr/g Ash	pCi ^{90}Sr/g Ash
	Counting Error*	Counting Error
BOV-1-N14-67	4.0 ± 2.0	14.1 ± 0.7
	3.8 ± 1.8	15.4 ± 0.6
BOV-2-N14-67	7.9 ± 1.7	12.3 ± 0.6
	5.9 ± 1.9	14.1 ± 0.7
BOV-3-N14-67	4.2 ± 1.7	13.5 ± 0.6
	4.8 ± 1.6	12.2 ± 0.6
BOV-4-N14-67	5.4 ± 1.7	9.9 ± 0.6
	0.0 ± 2.8	10.9 ± 0.8
BOV-5-N14-67	16.1 ± 1.1	6.7 ± 0.4
	14.6 ± 1.2	6.9 ± 0.4
BOV-6-N14-67	4.9 ± 1.6	12.0 ± 0.6
	6.0 ± 1.7	12.7 ± 0.6
AVERAGE	6.7 ± 1.7	11.7 ± 0.6

*2σ

APPENDIX B - PATHOLOGY

All animals sacrificed had probably grazed on and near the Rollercoaster sites their entire lives.

The animals are laid on their right sides. A ventral midline incision is made, and the skin and left foreleg and hindleg are reflected dorsally. The abdominal musculature is incised on the midline reflected dorsally. The ribs are cut at the costochondral rib and at the vertebra. The ribs are then removed and the thoracic cavity revealed.

1. BOV-1-N14-67

a. History.

DATE OF DEATH: 9 Aug. 67 HOUR: 0930 LOCATION: Tonopah Test Range

DATE OF NECROPSY: 9 Aug. 67 HOUR: 1000 LOCATION: Tonopah Test Range

SEX: Female AGE: Aged WEIGHT: 386.4 kg METHOD: Estimate

SPECIES: Bovine COMMON NAME: Cow BREED: Crossbred Shorthorn

b. External Appearance.

The animal is an aged lactating shorthorn cross in good condition. She is a dark red animal with long horns.

c. Digestive System.

Rumen is filled with ingesta. Ingesta is quite dry but of bright green color.

d. Genitourinary System.

Cow is lactating--milk flows freely when mammary gland is incised.

e. Respiratory System.

Diaphragmatic lobes are penetrated with a .243 bullet. Bullet transects both lobes on a horizontal line--entered on left side and exited on right side. Parietal cavity contains several 100 cc's of clotted blood. Lungs show intralobular emphysema.

f. Miscellaneous.

Cow is in excellent condition with much subcutaneous and perirenal fat.

g. Organ Weights and Measurements.

	Lung Weight:	2,895 grams	
Left Apical	165 grams	Right Apical	200 grams
Left Cardiac	115 grams	Right Cardiac	291 grams
Left Diaphragmatic	840 grams	Right Diaphragmatic	1,114 grams
Intermediate	170 grams		

Thyroid Weight: 53.0 grams

h. Necropsy Results.

Lung: Erythrocytes are present in lumina of all bronchioles which were observed.

Lymph Node: Microscopically, it appears that there is an increase in connective tissue in the medulla and a degree of lymphoid exhaustion in the cortex.

2. BOV-2-N14-67

a. History.

DATE OF DEATH: 9 Aug. 67 HOUR: 0930 LOCATION: Tonopah Test Range

DATE OF NECROPSY: 9 Aug. 67 HOUR: 1030 LOCATION: Tonopah Test Range

SEX: Female AGE: Aged WEIGHT: 398 kg METHOD: Estimate

SPECIES: Bovine COMMON NAME: Cow BREED: Crossbred Shorthorn

b. External Appearance.

The cow is an aged, lactating, white, horned, shorthorn crossbred animal in good condition.

c. Organ Weights and Measurements.

	Lung Weight:	3,308 grams	
Left Apical	158 grams	Right Apical	507 grams
Left Cardiac	130 grams	Right Cardiac	312 grams
Left Diaphragmatic	927 grams	Right Diaphragmatic	1,181 grams
Intermediate	93 grams		

Thyroid Weight: 32.5 grams

d. Necropsy Results.

Lung: There is focal hemorrhage into the alveoli and some bronchioles. There is focal atelectasis.

Cardiac Muscle: Few *Sarcocystis* spp. are present.

3. BOV-3-N14-67

a. History.

DATE OF DEATH: 9 Aug. 67 HOUR: 0930 LOCATION: Tonopah Test Range

DATE OF NECROPSY: 9 Aug. 67 HOUR: 1100 LOCATION: Tonopah Test Range

SEX: Female AGE: Aged WEIGHT: 329.5 kg METHOD: Estimate

SPECIES: Bovine COMMON NAME: Cow BREED: Hereford Crossbreed

b. External Appearance.

This is an aged, Hereford-crossbred, lactating cow in fair condition.

c. Organ Weights and Measurements.

	Lung Weight:	2,804 grams	
Left Apical	108 grams	Right Apical	365 grams
Left Cardiac	153 grams	Right Cardiac	211 grams
Left Diaphragmatic	841 grams	Right Diaphragmatic	997 grams
Intermediate	129 grams		

Thyroid Weight: 23.0 grams

d. Necropsy Results.

Kidney: Focal acute interstitial nephritis and focal pyelonephritis are present.

4. BOV-4-N14-67

a. History.

DATE OF DEATH: 9 Aug. 67 HOUR: 0930 LOCATION: Tonopah Test Range

DATE OF NECROPSY: 9 Aug. 67 HOUR: 1130 LOCATION: Tonopah Test Range

SEX: Female AGE: 2 years WEIGHT: 306 kg METHOD: Estimate

SPECIES: Bovine COMMON NAME: Cow BREED: Hereford Crossbreed

b. External Appearance.

Animal is in good condition.

c. Organ Weights and Measurements.

	Lung Weight:	3,175 grams	
Left Apical	181 grams	Right Apical	529 grams
Left Cardiac	124 grams	Right Cardiac	205 grams
Left Diaphragmatic	958 grams	Right Diaphragmatic	1,194 grams
Intermediate	84 grams		

Thyroid Weight: 25.0 grams (Before pathology sample taken)

Thyroid Weight: 24.0 grams (After pathology sample taken)

d. Necropsy Results.

Lymph Node: Focal hemorrhage in the cortex and medulla is present.

Kidney: Focal accumulations of immature and mature lymphocytes which is suggestive of early lymphosarcoma.

Cardiac Muscle: Moderate sarcosporidiosis is present.

5. BOV-5-N14-67

a. History.

DATE OF DEATH: 9 Aug. 67 HOUR: 0930 LOCATION: Tonopah Test Range

DATE OF NECROPSY: 9 Aug. 67 HOUR: 1200 LOCATION: Tonopah Test Range

SEX: Female AGE: 1 year WEIGHT: 177 kg METHOD: Estimate

SPECIES: Bovine COMMON NAME: Cow BREED: Hereford

b. External Appearance.

The animal is a yearling mixed Hereford heifer in good condition.

c. Digestive System.

Rumen contents are found in the peritoneal cavity.

d. Respiratory System.

Lung shows severe intralobular emphysema as if animal had been strenuously exerted prior to death.

e. Miscellaneous.

The ventral edge of the lateral surface of the left mandible is fractured from a bullet.

f. Organ Weights and Measurements.

	Lung Weight:	2,505 grams	
Left Apical	427 grams	Right Apical	124 grams
Left Cardiac	235 grams	Right Cardiac	188 grams
Left Diaphragmatic	832 grams	Right Diaphragmatic	610 grams
Intermediate	89 grams		

Thyroid Weight: 15 grams (Before pathology sample taken)
Thyroid Weight: 14 grams (After pathology sample taken)

g. Necropsy Results.

Kidney: Congestion is marked.

Skeletal Muscle: A slight myositis is present characterized by the presence of both mononuclear and polymorphonuclear leucocytes which are present in the perimysical tissue.

Lung: Focal alveolar edema and atelectasis are present.

Liver: There are focal accumulations of polymorphonuclear leucocytes present in the sinusoids--this is not indicative of acute hepatitis.

Cardiac Muscle: Focal accumulations of mononuclear leucocytes are present in the perimysium.

6. BOV-6-N14-67

a. History.

DATE OF DEATH: 9 Aug. 67 HOUR: 0930 LOCATION: Tonopah Test Range

DATE OF NECROPSY: 9 Aug. 67 HOUR: 1230 LOCATION: Tonopah Test Range

SEX: Female AGE: 2 years WEIGHT: 341 kg METHOD: Estimate

SPECIES: Bovine COMMON NAME: Cow BREED: Hereford

b. External Appearance.

Cow is a 2-year-old Hereford in excellent condition.

c. Respiratory System.

Animal shows signs of intralobular emphysema from exertion prior to death. Trachea contains 150 cc of clotted blood.

d. Organ Weights and Measurements.

	Lung Weight:	3,262 grams	
Left Apical	212 grams	Right Apical	303 grams
Left Cardiac	99 grams	Right Cardiac	192 grams
Left Diaphragmatic	1,643 grams	Right Diaphragmatic	748 grams
Intermediate	65 grams		

Thyroid Weight: 30 grams (Before pathology sample taken)

Thyroid Weight: 29 grams (After pathology sample taken)

e. Necropsy Results.

Lung: Extensive alveolar hemorrhage is present.

Cardiac Muscle: Slight sarcosporidiosis is present.

Skeletal Muscle: Slight sarcosporidiosis is present.

Spleen: Moderate myeloid metaplasia is present.

APPENDIX C - FOOD HABIT RESULTS

		Vol. %*
1. BOV-1-RuC-N14-67		
Hilaria jamesii	Stems-Leaves-Heads	98%
Orhyzopsis hymenoides	Seed-Leaves	1%
Atriplex canescens	Leaves-Seeds	1%
Sphaeralcea ambigua	Flower	T
Unidentified forb	Stems	T
Stanleya spp.	Seeds	T
Sporobolus airoides	Head-Leaves	T
Eriogonum spp.	Leaves	T
Euphorbia spp.	Leaves	T
Unidentified brouse	Leaves	T
Sarcobatus vermiculatus	Leaves-Stems	T
2. BOV-2-RuC-N14-67		
Hilaria jamesii	Stems-Leaves-Heads	63%
Sphaeralcea ambigua	Stems-Leaves-Flowers	30%
Atriplex canescens	Stems-Leaves	5%
Stanleya pinnata	Seeds-Fruit	2%
Salsola kali	Leaves	T
Orhyzopsis hymenoides	Seeds	T
Eriogonum spp.	Leaves	T
Unidentified forb	Stems	T
Sarcobatus vermiculatus	Leaves-Stems	T
3. BOV-3-RuC-N14-67		
Hilaria jamesii	Stems-Leaves	86%
Atriplex canescens	Stems-Leaves-Fruit-Seeds	10%
Sarcobatus vermiculatus	Stems-Leaves	3%
Orhyzopsis hymenoides	Seeds	1%
Sporobolus airoides	Heads	T

*Vol. % = percent by volume of a species found in the ingesta from each animal.

T = Trace

3. BOV-3-RuC-N14-67 (continued)		Vol. %
Sphaeralcea ambigua	Leaves-Stems	T
Eriogonum spp.	Leaves	T
Unidentified forbs	Stems	T
4. BOV-4-RuC-N14-67		
Hilaria jamesii	Leaves-Stems-Seeds	89%
Orhyzopsis hymenoides	Seeds-Stems	5%
Sphaeralcea ambigua	Seeds-Fruit-Flowers-Leaves-Stems	4%
Sarcobatus vermiculatus	Stems-Leaves	1%
Sporobolus airoides	Heads-Leaves	1%
Stanleya pinnata	Seeds	T
Ephedra nevadensis	Stems	T
Atriplex canescens	Leaves	T
5. BOV-5-RuC-N14-67		
Hilaria jamesii	Stems-Leaves	92%
Sarcobatus vermiculatus	Stems-Leaves	5%
Orhyzopsis hymenoides	Seeds-Stems	3%
Sphaeralcea ambigua	Seeds	T
Eriogonum spp.	Leaves	T
Sporobolus airoides	Heads	T
Franseria acanthicarpa	Fruit-Leaves	T
Atriplex canescens	Leaves	T
6. BOV-6-RuC-N14-67		
Hilaria jamesii	Leaves-Stems	90%
Orhyzopsis hymenoides	Seeds-Stems	8%
Sphaeralcea ambigua	Leaves	1%
Sporobolus airoides	Heads-Leaves	1%
Sarcobatus vermiculatus	Leaves-Fruit	T
Atriplex canescens	Leaves	T
Franseria acanthicarpa	Fruit	T
Unidentified forb	Stems	T
Ephedra viridis	Stems	T